MINERAL COMPOSITION OF *ATRIPLEX HYMENELYTRA* GROWING IN THE NORTHERN MOJAVE DESERT

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ABSTRACT.— Fifty samples of *Atriplex hymenelytra* (Torr.) S. Wats. were collected from several different locations in southern Nevada and California to test variability in mineral composition. Only Na, V, P, Ca, Mg, Mn, and Sr in the samples appeared to represent a uniform population resulting in normal curves for frequency distribution. Even so, about 40 percent of the variance for these elements was due to location. All elements differed enough with location so that no element really represented a uniform population. The coefficient of variation for most elements was over 40 percent and one was over 100 percent. The proportion of variance due to analytical variation averaged 16.2 ± 13.1 percent (standard deviation), that due to location was 43.0 ± 13.4 percent, and that due to variation of plants within location was 40.7 ± 13.0 percent.

Atriplex hymenelytra (Torr.) S. Wats. (desert holly) is a halophyte that accumulates NaCl in leaves (Wallace and Romney 1972, Romney et al. 1973, Wallace et al. 1973a, 1973b). Many *Atriplex* species, including *A. hymenelytra,* have salt glands in leaves (Jones and Hodgkinson (1970).

Atriplex hymenelytra generally grows in the mountain passes in southern Nevada, and it is common along roadways where soil has been disturbed. It is very common in Death Valley (Hunt 1966). The objective of this work was to study mineral composition of leaves of this plant species collected from a relatively wide area of the northern Mojave Desert. A somewhat similar study was made of another species (*Lycium andersonii*) collected from a relatively narrow range (within 20 km) of the same desert (Wallace et al. 1980, this volume).

TABLE 1. Statistical information for the mineral composition of *A. hymenelytra*.

		Mean	S.D.	C.V.	Lowest	Highest
P	ug/g	3434	1554	0.45	307	6739
Na	%	8.791	2.201	0.25	3.12	15.84
K	%	5.435	2.172	0.40	2.04	13.59
Ca	%	1.409	0.735	0.52	0.31	5.08
Mg	ug/g	4547	1868	0.41	2057	11717
Zn	ug/g	24.5	20.6	0.84	Near 0	82
Cu	ug/g	5.3	3.9	0.74	0.9	23
Fe	ug/g	305	137	0.45	161	828
Mn	ug/g	146	116	0.79	27	673
B	ug/g	83.3	70.3	0.84	18	250
Al	ug/g	346	208	0.60	46	1101
Si	ug/g	1587	1348	0.85	241	8892
Ti	ug/g	41.1	26.2	0.64	7.9	124
V	ug/g	4.7	1.0	0.22	2.7	8.0
Mo	ug/g	2.8	2.4	0.86	0.5	11.0
Sr	ug/g	288	187	0.65	27	953
Ba	ug/g	10.5	7.0	0.67	2.6	41
Li	ug/g	11.2	12.1	1.08	0.0	89
Pb	ug/g	9.8	8.9	0.91	0.0	36

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MATERIALS AND METHODS

Fifty samples of *Atriplex hymenelytra* (Torr.) S. Wats. were collected in southern Nevada and adjacent areas in California in early 1976. Some were from the Nevada Test Site and others were from along a highway between Baker, California, and Mercury, Nevada. A range of about 150 km between sample sites occurred. Usually 4 or 5 samples were taken from a location and each sample represented one individual plant, as in the *Lycium andersonii* collection (Wallace et al. 1980, this volume). Samples were not washed and were prepared for analysis by emission spectrography. Each sample was assayed in triplicate.

The sample sites were east and south of the city Shoshone, near Tacoma, near Pahrump, on Highway 95, and in Rock Valley of the Nevada Test Site.

RESULTS AND DISCUSSION

Only 134 of the 150 replicate analyses were used in the statistical evaluation because of various failures in analysis of some of the elements. The means, standard deviations, coefficients of variation (C.V.), and proportion of variance due to analytical error are given in Table 1. As a generality, the C.V. values are much larger than the corresponding values for *L. andersonii* (Wallace et al. 1980, this volume). The proportion of the variance due to analytical error was relatively low, however (Table 1). Except for K, V, and Li it was 20 percent or less, sometimes much less. There was no relationship between these values and the C.V. ($r = -0.21$) shown in Table 1.

Frequency distribution of metal concentrations for 19 different elements are presented in Figures 1 to 5. A statistical evaluation of

Table 1 continued.

Variance ratio			Chi^2 goodness of fit test of normality	Skewness at 0.05?	Substitute kurtosis coeff. significant?
Analytical error	Within location	Between location			
0.14	0.32	0.54	Cannot rej.	No	No
0.20	0.40	0.41	Cannot rej.	No	No
0.40	0.41	0.19	Reject	Yes	No
0.11	0.46	0.43	Cannot rej.	Yes	Yes
0.07	0.40	0.53	Cannot rej.	Yes	No
0.13	0.41	0.45	Reject	Yes	No
0.02	0.58	0.40	Reject	Yes	Yes
0.18	0.33	0.49	Reject	Yes	Yes
0.15	0.49	0.36	Cannot rej.	Yes	Yes
0.02	0.18	0.79	Reject	Yes	No
0.10	0.51	0.39	Reject	Yes	Yes
0.07	0.71	0.22	Reject	Yes	Yes
0.15	0.45	0.39	Reject	Yes	No
0.43	0.17	0.40	Cannot rej.	No	No
0.04	0.44	0.53	Reject	Yes	Yes
0.05	0.51	0.45	Cannot rej.	Yes	No
0.18	0.38	0.44	Cannot rej.	Yes	No
0.45	0.30	0.24	Reject	Yes	Yes
0.18	0.28	0.53	Reject	No	Yes

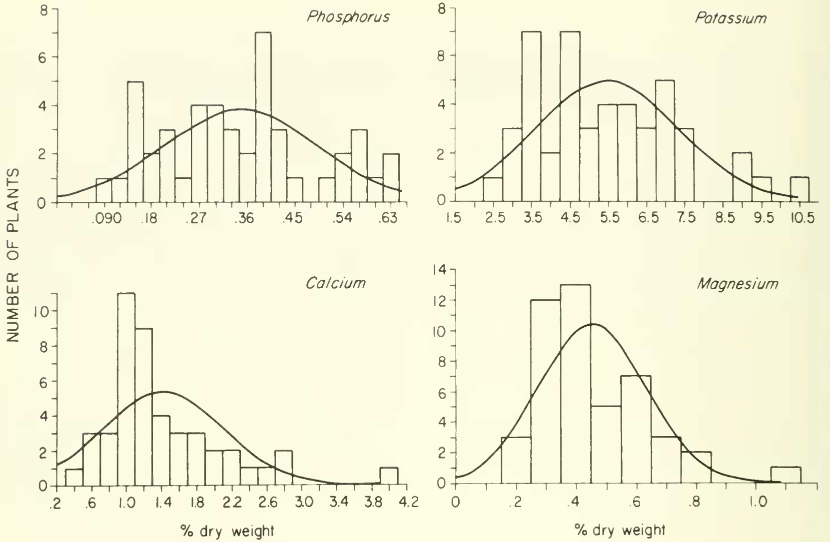

Fig. 1. Frequency distribution of P, K, Ca, and Mg in 50 samples of *Atriplex hymenelytra* leaves.

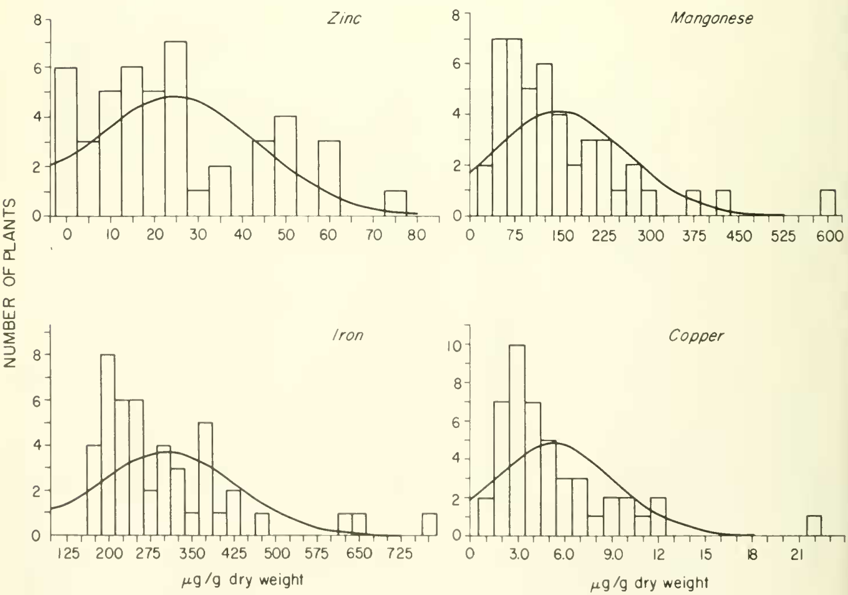

Fig. 2. Frequency distribution of Zn, Mn, Fe, and Cu in 50 samples of *Atriplex hymenelytra* leaves.

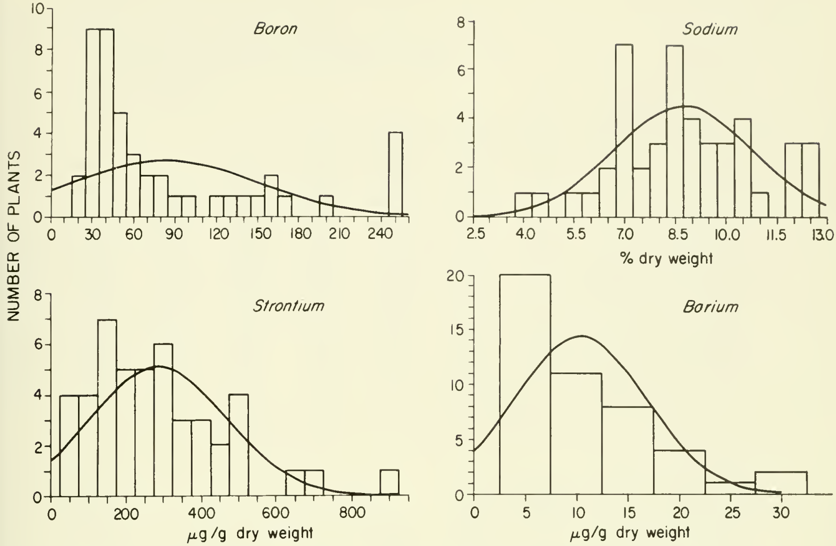

Fig. 3. Frequency distribution of B, Na, Sr, and Ba in 50 samples of *Atriplex hymenelytra* leaves.

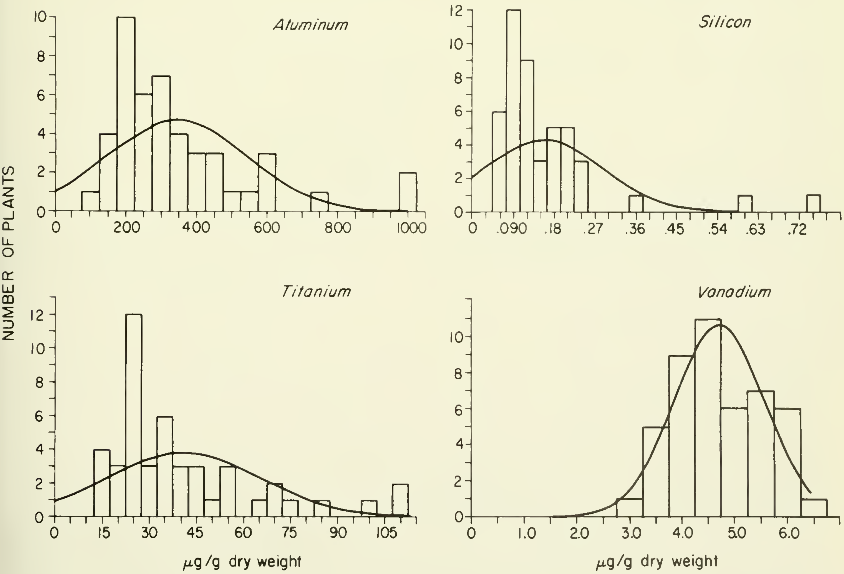

Fig. 4. Frequency distribution of Al, Si, Ti, and V in 50 samples of *Atriplex hymenelytra* leaves.

TABLE 2. Correlation matrix for the pairs of elements indicated in the analysis of *Atriplex hymenelytra*°.

	P	Na	K	Ca	Mg	Zn	Cu	Fe	Mn	B
Na	–0.188									
K	–0.049	0.175								
Ca	–0.376	–0.361	0.172							
Mg	–0.326	–0.163	0.175	0.492						
Zn	0.417	0.039	0.206	–0.042	–0.372					
Cu	0.521	–0.092	0.289	–0.058	–0.228	0.462				
Fe	0.155	–0.075	–0.153	–0.081	0.257	–0.147	0.002			
Mn	0.423	–0.153	0.083	–0.125	–0.074	0.214	0.473	–0.126		
B	0.120	–0.127	–0.378	–0.131	–0.110	–0.192	–0.303	0.405	–0.232	
Al	0.168	–0.104	–0.202	–0.017	0.294	–0.161	–0.020	0.920	–0.118	0.391
Si	0.260	–0.133	–0.204	–0.131	0.209	–0.148	0.060	0.862	–0.102	0.361
Ti	0.122	0.038	–0.124	–0.135	0.228	0.212	–0.065	0.861	–0.180	0.376
V	–0.398	0.415	0.218	0.263	0.293	–0.295	–0.278	–0.033	–0.287	–0.119
Mo	0.3807	0.077	0.338	–0.091	0.078	0.075	0.577	–0.177	0.487	–0.418
Sr	–0.255	–0.126	–0.111	0.185	0.213	–0.277	–0.225	0.056	–0.103	–0.100
Ba	0.061	0.040	–0.074	–0.114	0.408	–0.256	0.013	0.719	0.135	0.138
Li	0.076	–0.064	–0.040	–0.079	–0.146	–0.168	–0.205	–0.294	0.330	0.108
Pb	0.073	0.412	0.165	–0.287	–0.012	0.163	0.180	0.068	–0.026	–0.128

	Al	Si	Ti	V	Mo	Sr	Ba	Li
Si	0.920							
Ti	0.861	0.805						
V	–0.007	–0.124	0.051					
Mo	–0.240	–0.198	–0.161	–0.128				
Sr	0.070	–0.037	0.118	0.206	0.129			
Ba	0.718	0.696	0.677	0.062	0.033	0.118		
Li	–0.277	–0.195	–0.249	0.002	0.022	–0.245	–0.306	
Pb	0.024	0.062	0.044	0.194	–0.007	–0.142	0.177	–0.061

°A value of ± 0.168 needed for significance at the 0.05 level.

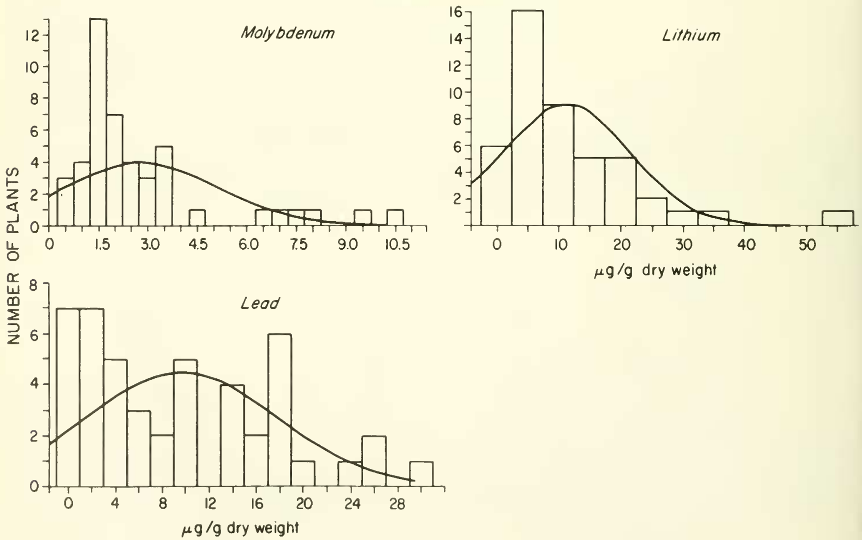

Fig. 5. Frequency distribution of Mo, Li, and Pb in 50 samples of *Atriplex hymenelytra* leaves.

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TREE PRINTED OVER CORRELATION MATRIX (SCALED 0-100).
CLUSTERING BY AVERAGE DISTANCE METHOD.
   VARIABLE
NAME         NO.
                   ------------------------------------------------------/
P            (  2) 76 68 71/70/53/40 30 53 47/31 33 37 57 58 63 56 53 56/
                          /  /  /           /                          /
                   ------/  /  /           /                          /
CU           (  8) 78/73/73/39/45 36 58 64/47 38 38 50 49 53 46 50 34/
                    /  /  /  /           /                          /
                   /  /  /  /           /                          /
MO           ( 16)/74/53/51/46 43 49 66/45 53 56 41 37 40 41 51 29/
                    /  /  /           /                          /
                   /  /  /           /                          /
MN           ( 10)/60/66/42 35 48 54/43 46 44 43 44 44 41 43 38/
                    /  /           /                          /
                   /  /           /                          /
ZN           (  7)/41/52 35 58 60/47 31 36 42 41 42 39 37 40/
                    /           /                          /
                   /           /                          /
LI           ( 19)/46 50 46 43/46 42 37 35 36 40 37 34 55/
                             /                          /
                   ---------/                          /
NA           (  3) 70/70/58/31 41 43 46 44 43 51 52 43/
                    /  /  /                          /
                   /  /  /                          /
V            ( 15)/59/60/63 64 60 48 49 43 52 53 44/
                    /  /                          /
                   /  /                          /
PB           ( 20)/58/35 49 42 46 51 53 52 58 43/
                    /                          /
                   /                          /
K            (  4)/58 58 44 42 39 39 43 46 31/
                                            /
                   ------------------------/
CA           (  5) 74/59/45 49 43 43 44 43/
                    /  /                 /
                   /  /                 /
MG           (  6)/60/62 64 60 61 70 44/
                    /                 /
                   /                 /
SR           ( 17)/52 53 48 55 55 45/
                                   /
                   ---------------/
FE           (  9) 95 93/93/85/70/
                       /  /  /  /
                   ---/  /  /  /
AL           ( 12) 95/93/85/69/
                    /  /  /  /
                   /  /  /  /
SI           ( 13)/90/84/68/
                    /  /  /
                   /  /  /
TI           ( 14)/83/68/
                    /  /
                   /  /
BA           ( 18)/56/
                    /
                   /
B            ( 11)/
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Fig. 6. Cluster analyses tree described from the correlation matrix. The values in this tree have been scaled 0 to 100 according to the following: Value above 0, correlation –1.000; value above 5, correlation –0.900; value above 10, correlation –0.800; value above 15, correlation –0.700; value above 20, correlation –0.600; value above 25, correlation –0.500; value above 30, correlation –0.400; value above 35, correlation –0.300; value above 40, correlation –0.200; value above 45, correlation –0.100; value above 50, correlation 0.000; value above 55, correlation 0.100; value above 60, correlation 0.200; value above 65, correlation 0.300; value above 70, correlation 0.400; value above 75, correlation 0.500; value above 80, correlation 0.600; value above 85, correlation 0.700; value above 90, correlation 0.800; value above 95, correlation 0.900.

the normality of each of the histograms is presented in Table 1. Even though the samples were collected over a range of about 150 km, normality could not be rejected for several of the elements. Included were P, Ca, and Mg (Fig. 1), Zn and Mn (Fig. 2), Na, Sr, and Ba (Fig. 3), and V (Fig. 4).

The mean Na concentration was 8.79 percent. The C.V. of this value was 24.6 percent, which was, except for V, lowest of the elements. Only 20 percent of this 24.6 percent was due to analytical variance. The frequency distribution for Na gave a normal curve (Fig. 3). It is of interest that all the samples from the collection covering about 150 km resulted in a uniform population for Na. It must be recognized that part of the Na would be on the leaf surface due to salt glands (Jones and Hodgkinson 1970).

The cluster analysis (Fig. 6) showed a marked relationship among the "dust" elements Fe, Al, Si, and Ti. An explanation of the variable clustering process as shown in the diagram (Fig. 6) follows: the process begins with the cluster consisting of variable Cu (8), the second variable listed in the diagram. This cluster joins with the cluster below it consisting of the variable Mo (16). The new cluster is indicated on the figure by the intersection of the dashes beginning above variable Cu (8), with the slashes starting next to the variable Mo (16).

This cluster joins with the cluster below it consisting of the variable Mn (10). The new cluster is indicated on the tree by the intersection of the dashes beginning above variable Cu (8), with the slashes starting next to variable Mn (10).

This cluster joins with the cluster above it consisting of the variable P (2). The new cluster is indicated on the tree by the intersection of the dashes beginning above variable P (2) with the slashes starting next to variable Mn (10). This cluster joins with the cluster below it consisting of the variable Zn (7). The new cluster is indicated on the tree by the intersection of the dashes beginning above variable P (2), with the slashes starting next to variable Li (19).

This cluster joins with the cluster below it consisting of the variables Na (3) down to K (4). The new cluster is indicated on the tree by the intersection of the dashes beginning above variable P (2), with the slashes starting next to variable K (4). The process continues until each variable is joined to at least one other variable.

Twenty-seven significant negative correlation coefficients were observed among pairs of elements (Table 2). This is a greater proportion than observed by Gartner (1976) for East Coast vegetation.

Acknowledgments

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